CLAIMS

1. A single crystal substrate comprising:

a langasite substrate with a SAW propagation surface; and

input and output IDTs having electrodes on the surface for launching and/or detecting surface acoustic waves, wherein a direction of surface wave propagation is parallel to an X′-axis, and the substrate further has an Z′-axis perpendicular to the surface and a Y′-axis parallel to the surface and perpendicular to the X′-axis, the langasite substrate having a crystal orientation defined by modified axes X, Y and Z, the relative orientation of axes X′, Y′ and Z′ being defined by Euler angles ϕ, θ and ψ, in which ϕ is in a range of $8° \leq \phi \leq 25°$, θ is in a range of $15° \leq \theta \leq 30°$, and ψ is in a range of $55° \leq \psi \leq 85°$.

2. The single crystal substrate according to claim 1, wherein optimal Euler angles of the langasite are $\phi = 10°$, $\theta = 23.6°$ and $\psi = 78.8°$.

3. A single crystal substrate comprising:

a langasite substrate with a SAW propagation surface; and

input and output IDTs having electrodes on the surface for launching and/or detecting surface acoustic waves, wherein a direction of surface wave propagation is parallel to an X′-axis, and the substrate further has an Z′-axis perpendicular to the surface and a Y′-axis parallel to the surface and perpendicular to the X′-axis, the langasite substrate having a crystal orientation defined by modified axes X, Y and Z, the relative orientation of axes X′, Y′ and Z′ being defined by Euler angles ϕ, θ and ψ, in which ϕ is 0°, θ is in a range of $12° \leq \theta \leq 17°$, and ψ is in a range of $73° \leq \psi \leq 78°$.

4. The single crystal substrate according to claim 3, wherein optimal Euler angles of the langasite are $\phi = 0°$, $\theta =$

14.6° and ψ = 76.2°.

5. A single crystal substrate comprising:

a quartz substrate with a SAW propagation surface; and

input and output IDTs having electrodes on the surface for launching and/or detecting surface acoustic waves, wherein a direction of surface wave propagation is parallel to an X'-axis, and the substrate further has an Z'-axis perpendicular to the surface and a Y'-axis parallel to the surface and perpendicular to the X'-axis, the quartz substrate having a crystal orientation defined by modified axes X, Y and Z, the relative orientation of axes X', Y' and Z' being defined by Euler angles ϕ, θ and ψ, in which ϕ is in a range of $-5° \leq \phi \leq +5°$, θ is in a range of $60° \leq \theta \leq 80°$ and ψ is in a range of $-5° \leq \psi \leq +5°$.

6. The single crystal substrate according to claim 5, wherein optimal Euler angles of the quartz are ϕ = 0°, θ = 70.5° and ψ = 0°.

7. A single crystal substrate comprising:

a quartz substrate with a SAW propagation surface; and

input and output IDTs having electrodes on the surface for launching and/or detecting surface acoustic waves, wherein a direction of surface wave propagation is parallel to an X'-axis, and the substrate further has an Z'-axis perpendicular to the surface and a Y'-axis parallel to the surface and perpendicular to the X'-axis, the quartz substrate having a crystal orientation defined by modified axes X, Y and Z, the relative orientation of axes X', Y' and Z' being defined by Euler angles ϕ, θ and ψ, in which ϕ is 0°, θ is in a range of $17° \leq \theta \leq 23°$ and ψ is in a range of $10° \leq \psi \leq 20°$.

8. The single crystal substrate according to claim 7, wherein optimal Euler angles of the quartz are ϕ = 0°, θ = 20° and ψ = 13.7°.

9. A single crystal substrate comprising:

a lithium tantalate substrate with a SAW propagation surface; and

input and output IDTs having electrodes on the surface for launching and/or detecting surface acoustic waves, wherein a direction of surface wave propagation is parallel to an X'-axis, and the substrate further has an Z'-axis perpendicular to the surface and a Y'-axis parallel to the surface and perpendicular to the X'-axis, the lithium tantalate substrate having a crystal orientation defined by modified axes X, Y and Z, the relative orientation of axes X', Y' and Z' being defined by Euler angles ϕ, θ and ψ, in which ϕ is in a range of $-5° \leq \phi \leq +5°$, θ is in a range of $70° \leq \theta \leq 90°$ and ψ is in a range of $85° \leq \psi \leq 95°$.

10. The single crystal substrate according to claim 9, wherein optimal Euler angles of the lithium tantalate are $\phi = 0°$, $\theta = 79°$ and $\psi = 90°$.

11. A single crystal substrate comprising:

a lithium tantalate substrate with a SAW propagation surface; and

input and output IDTs having electrodes on the surface for launching and/or detecting surface acoustic waves, wherein a direction of surface wave propagation is parallel to an X'-axis, and the substrate further has an Z'-axis perpendicular normal to the surface and a Y'-axis parallel to the surface and perpendicular to the X'-axis, the lithium tantalate substrate having a crystal orientation defined by modified axes X, Y and Z, the relative orientation of axes X', Y' and Z' being defined by Euler angles ϕ, θ and ψ, in which ϕ is in a range of $-5° \leq \phi \leq +5°$, θ is in a range of $160° \leq \theta \leq 180°$ and ψ is in a range of $85° \leq \psi \leq 95°$.

12. The single crystal substrate according to claim 11, wherein optimal Euler angles of the lithium tantalate are $\phi = 0°$, $\theta = 168°$ and $\psi = 90°$.

13. A single crystal substrate comprising:

a lithium tantalate substrate with a SAW propagation surface; and

input and output IDTs having electrodes on the surface for launching and/or detecting surface acoustic waves, wherein a direction of surface wave propagation is parallel to an X'-axis, and the substrate further has an Z'-axis perpendicular to the surface and a Y'-axis parallel to the surface and perpendicular to the X'-axis, the lithium tantalate substrate having a crystal orientation defined by modified axes X, Y and Z, the relative orientation of axes X', Y' and Z' being defined by Euler angles ϕ, θ and ψ, in which ϕ is in a range of $-5^\circ \leq \phi \leq +5^\circ$, θ is in a range of $20^\circ \leq \theta \leq 40^\circ$ and ψ is in a range of $5^\circ \leq \psi \leq 25^\circ$.

14.The single crystal substrate according to claim 13, wherein optimal Euler angles of the lithium tantalate are $\phi = 0^\circ$, $\theta = 30^\circ$ and $\psi = 16.5^\circ$.

15. A cutting method of a single crystal substrate comprising the steps of:

(a) defining a crystal orientation based on modified axes X, Y and Z, for the surface of the single crystal substrate which surface acoustic waves are propagated;

(b) defining X', Y' and Z' axes on the single crystal substrate, in which a direction of surface wave of the propagation is parallel to X'-axis and the Z'-axis is perpendicular to the surface wave and the Y'-axis is parallel to the surface and normal to the X'-axis;

(c) defining the X', Y' and Z' axes defined at (b) as relative orientation Euler angles of crystals, ϕ, θ and ψ; and

(d) setting a range of the ϕ, θ, and ψ defined at (c) in an optimal range in accordance with a type of the substrate.

16. The method according to claim 15, wherein the single

crystal substrate is a langasite substrate.

17. The method according to claim 15, wherein the single crystal substrate is a quartz substrate.

18. The method according to claim 15, wherein the single crystal substrate is a lithium tantalate substrate.